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Ojanen

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(54) **INSERT WITH OFFSET APEX FOR A CUTTER BIT AND A CUTTER BIT HAVING THE SAME**

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B28D 1/18	(2006.01)
E21C 35/18	(2006.01)

(52) **U.S. Cl.**

CPC ***E21C 35/183*** (2013.01); ***B28D 1/186*** (2013.01); *E21C 2035/1816* (2013.01)

(58) **Field of Classification Search**

USPC 299/79.1, 100, 101, 108, 111, 113; 175/420.1, 420.2, 426, 428, 430–432, 175/434, 435

See application file for complete search history.

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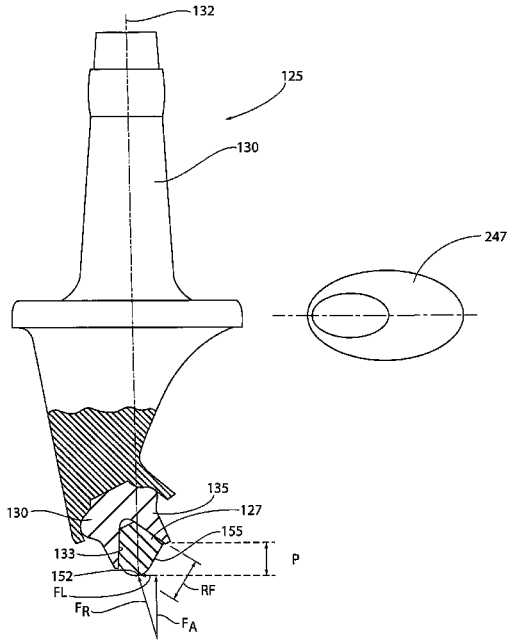
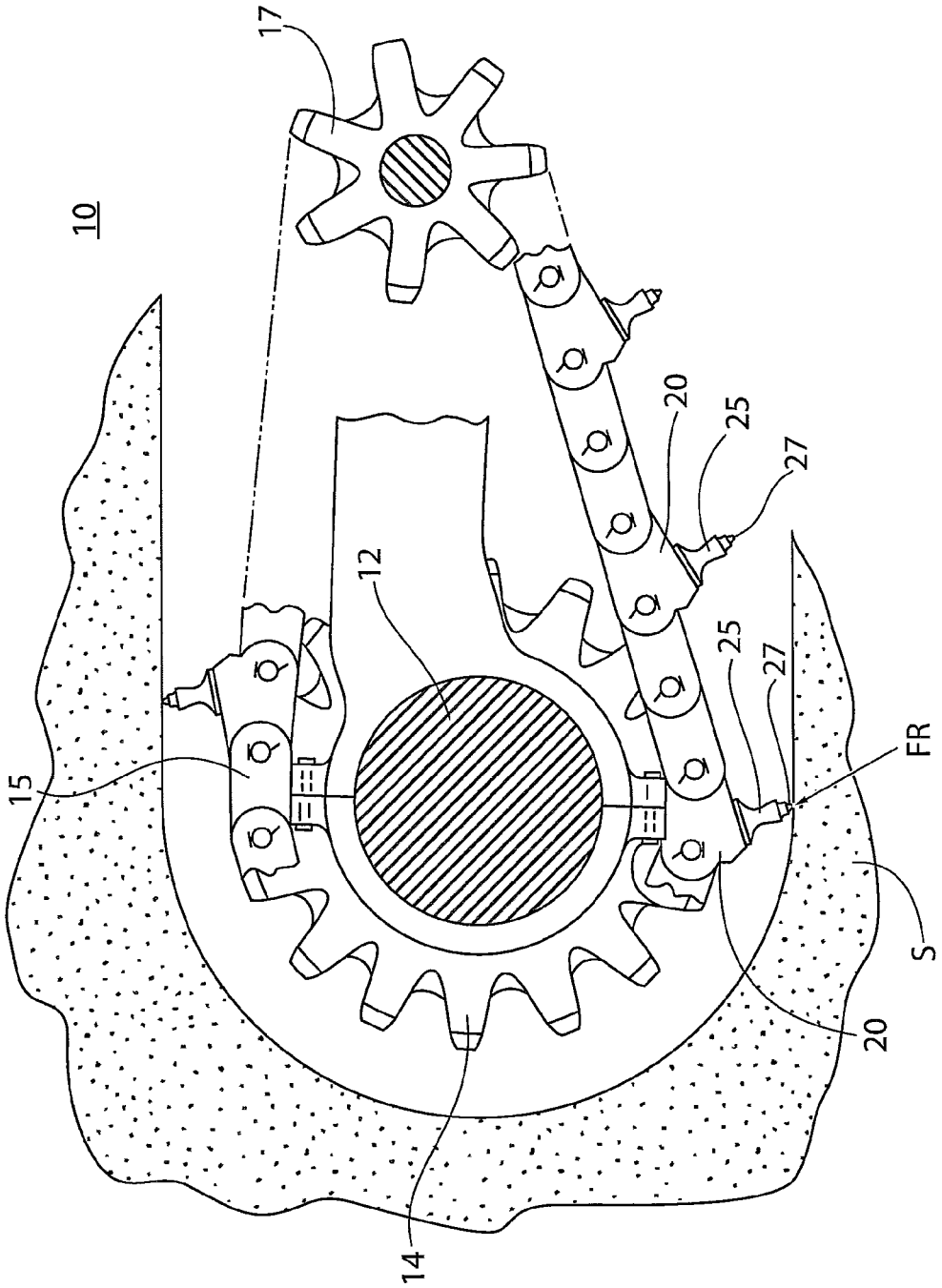
(57) **ABSTRACT**

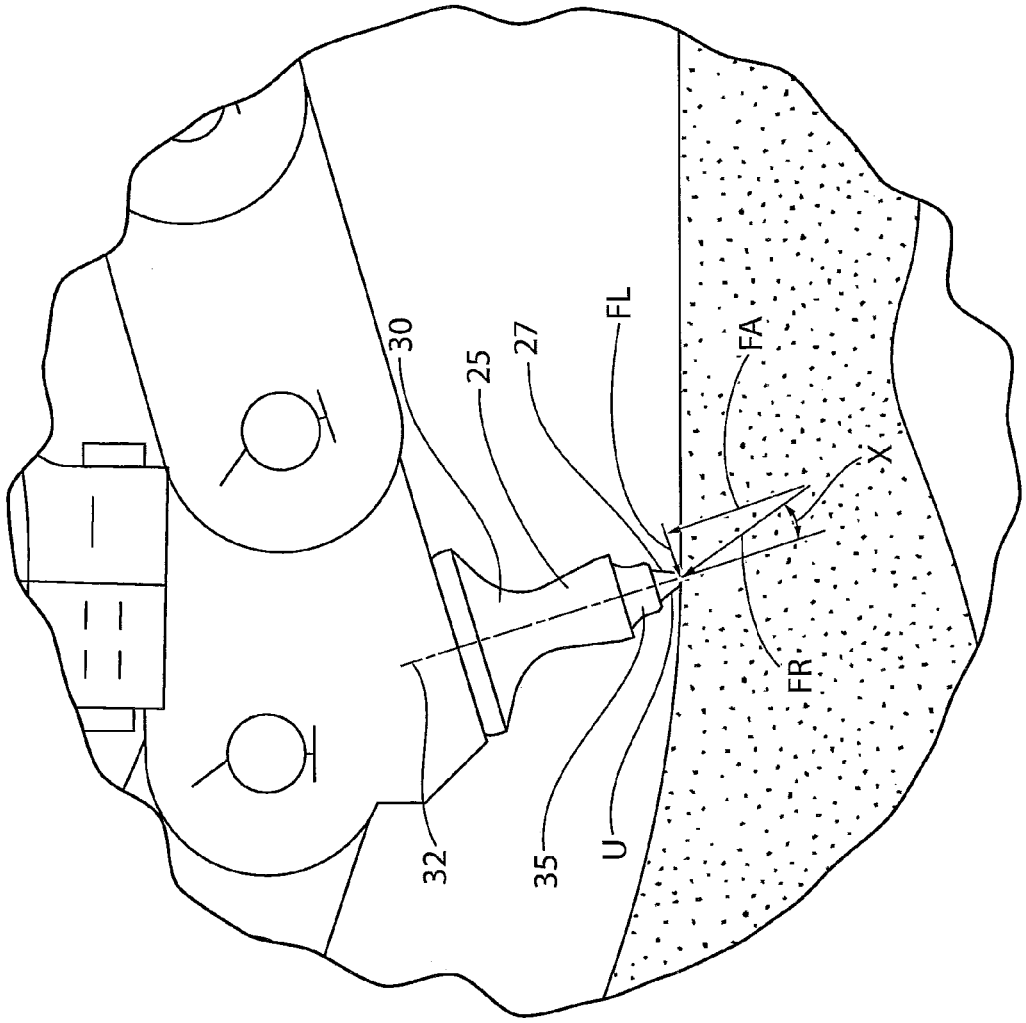
A non-rotatable cutter bit for mining and construction operations having a central longitudinal axis extending therethrough includes an insert at one end. The insert has a central longitudinal axis and the apex is offset from the central longitudinal axis to provide an elongated rake face. With the insert mounted within the cutter body, the central longitudinal axis of the cutter body intersects with the apex such that the cutter body may be easily exchanged with conventional cutter bodies. The insert may also be mounted directly to the body without using an insert holder. The insert also has applications in oil and gas drilling operations.

31 Claims, 9 Drawing Sheets





PRIOR ART
FIG. 1



PRIOR ART
FIG. 2

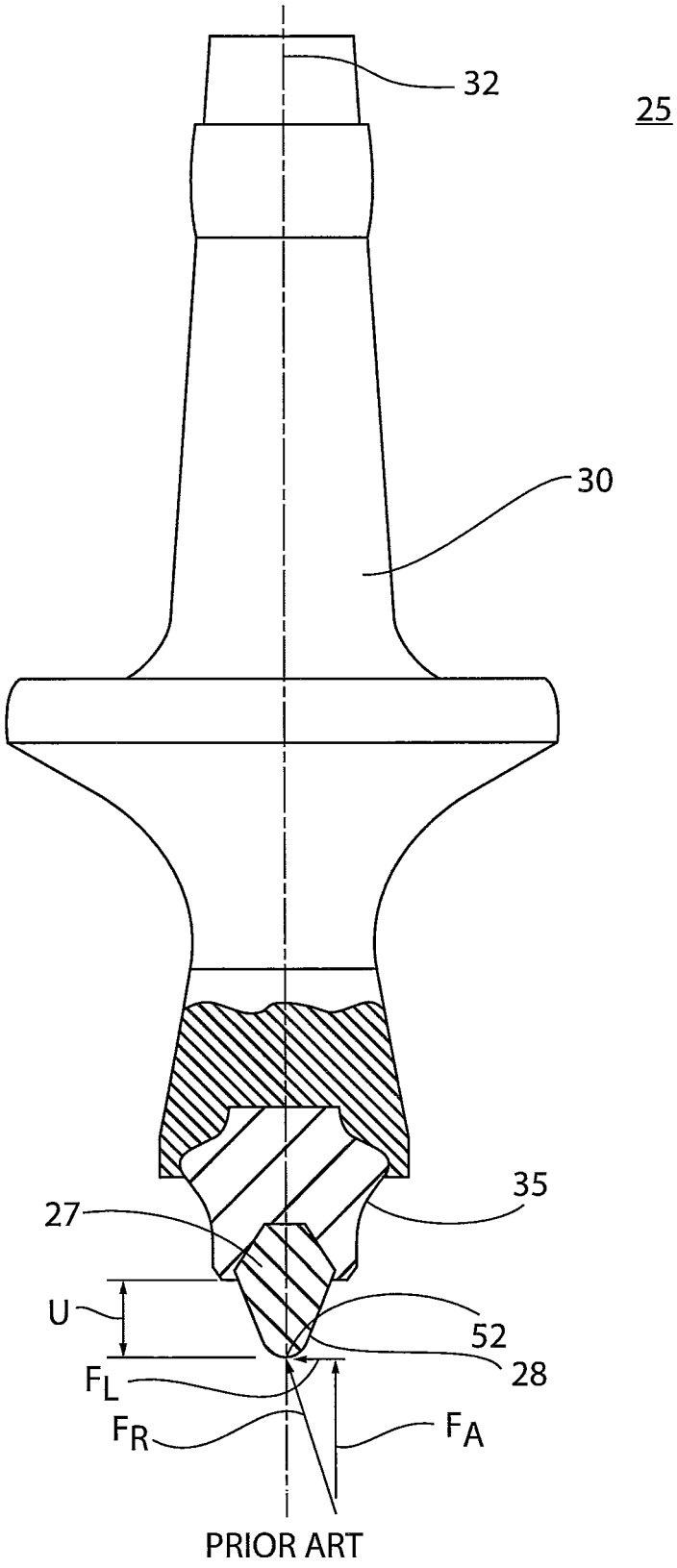


FIG. 3

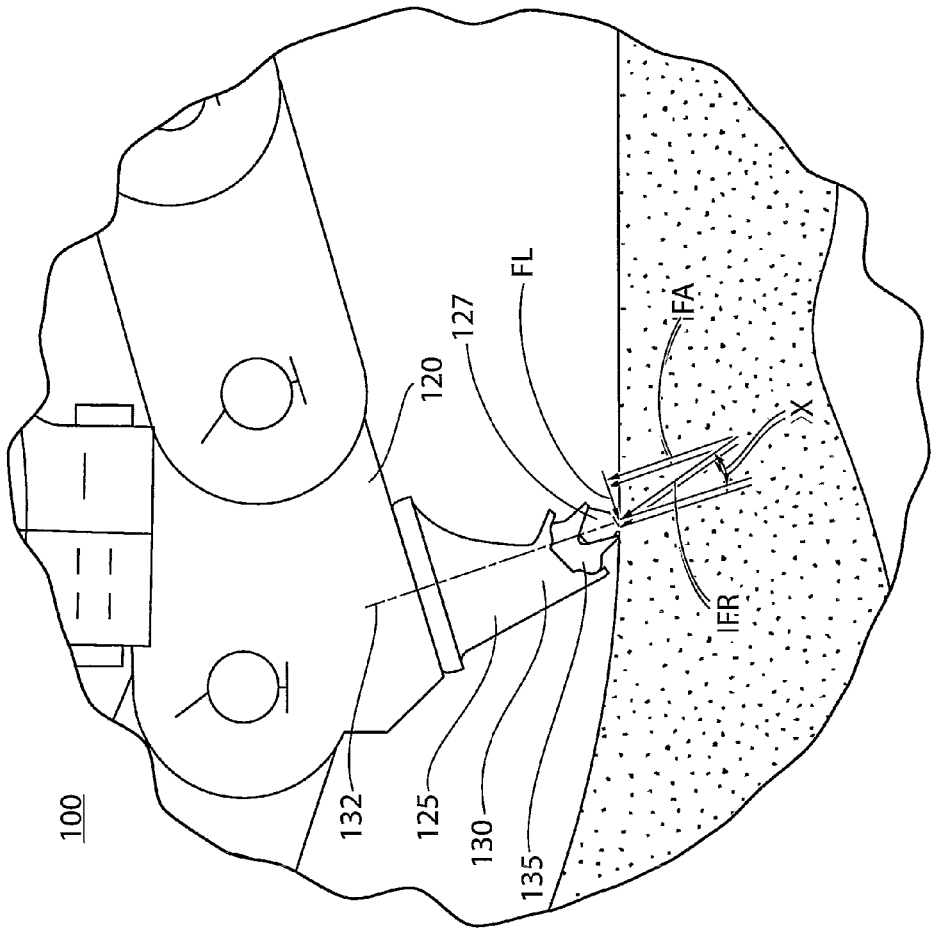


FIG. 4

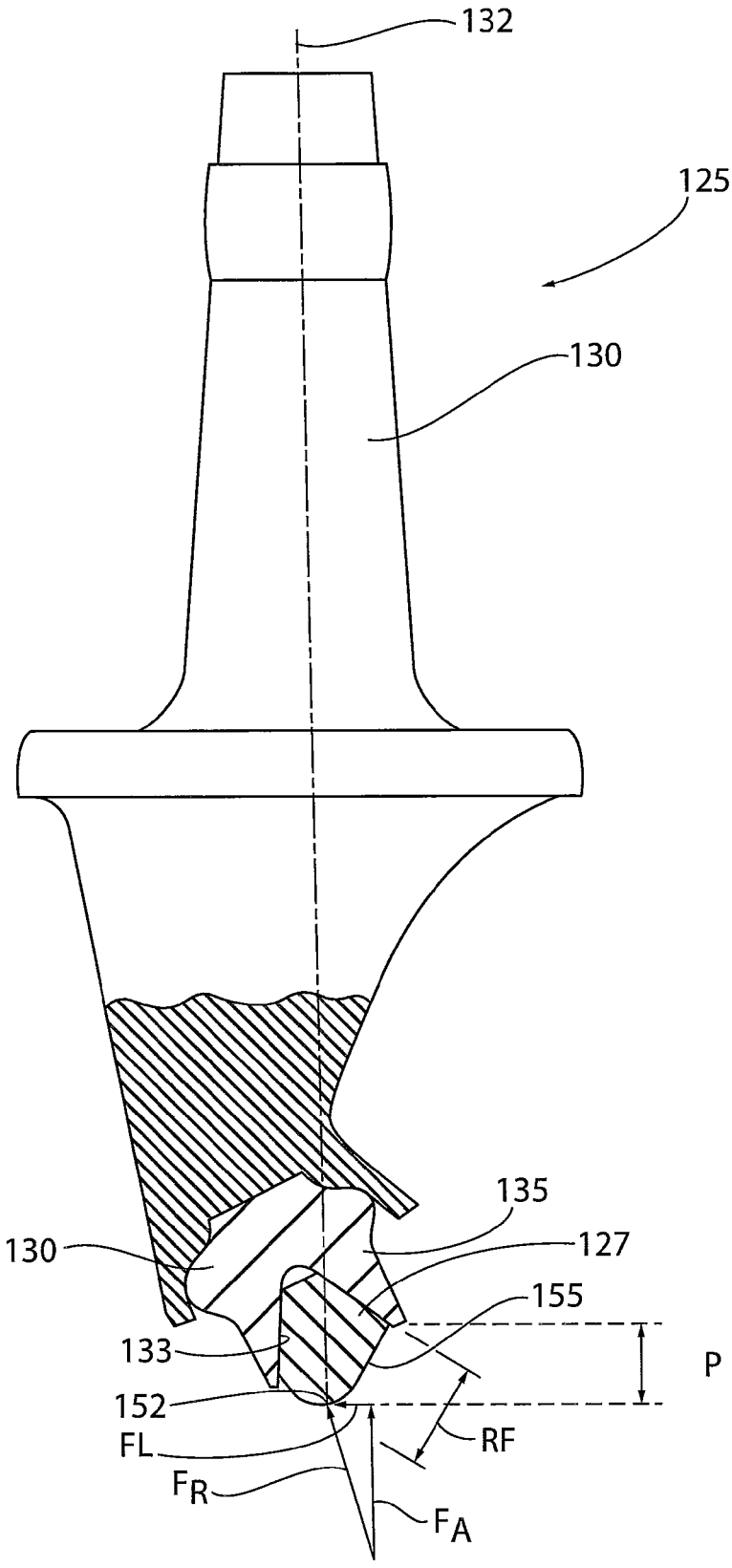


FIG. 5

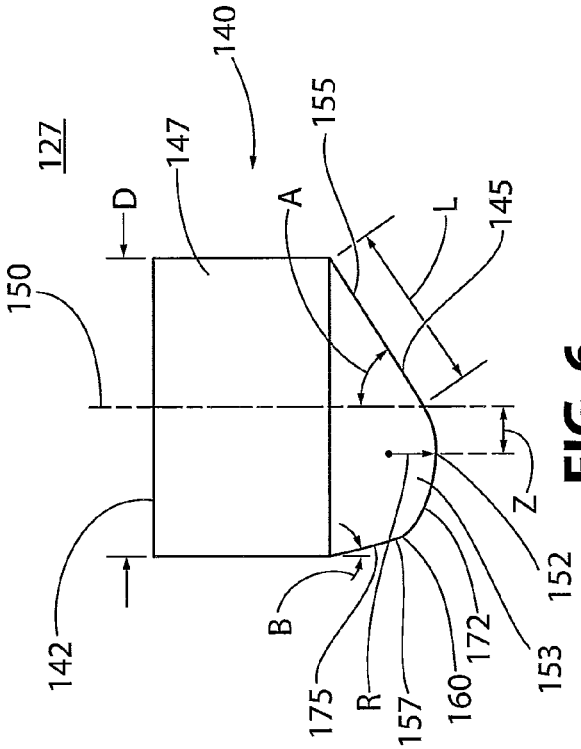


FIG. 6

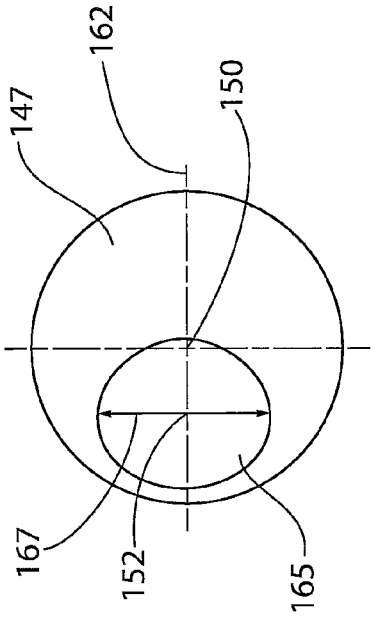


FIG. 8

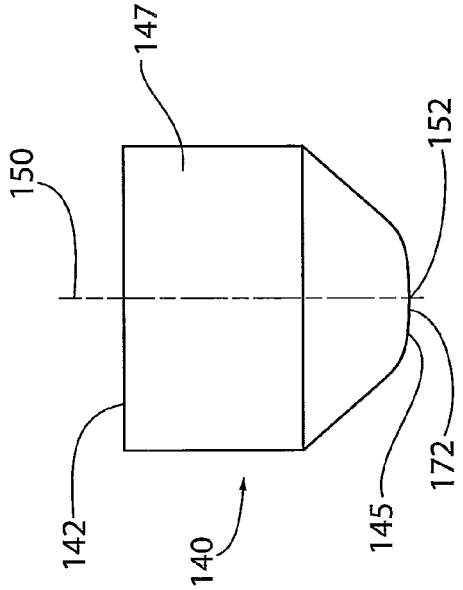


FIG. 7

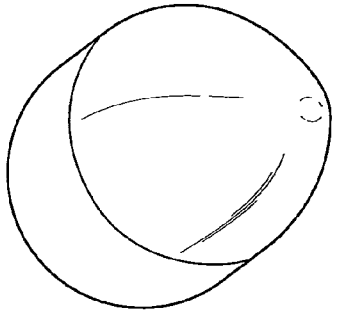


FIG. 9

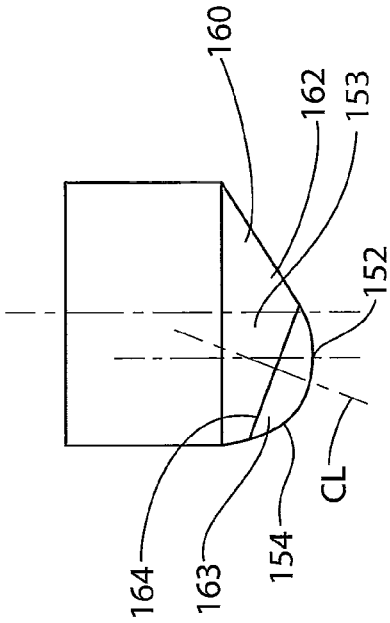


FIG. 11

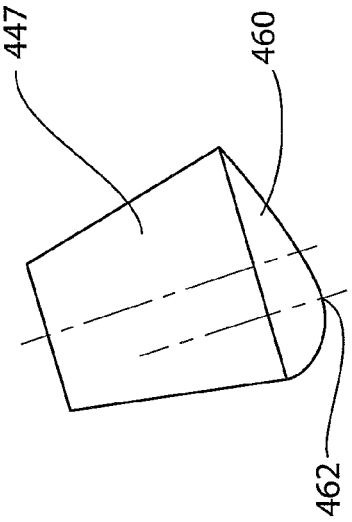


FIG. 13

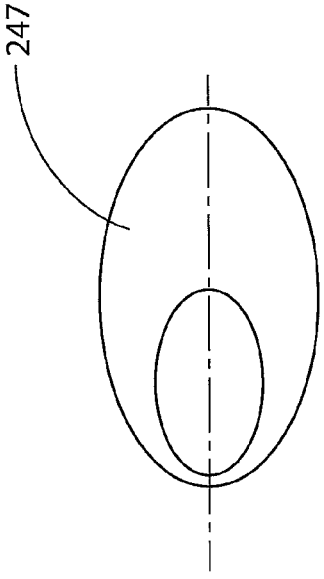


FIG. 10

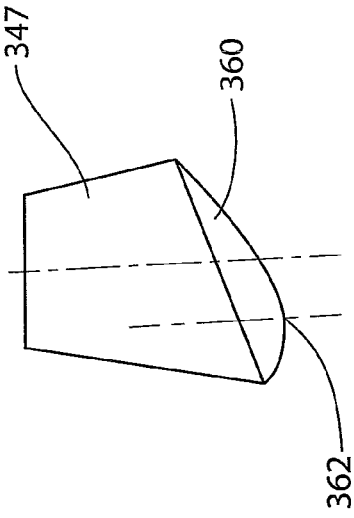


FIG. 12

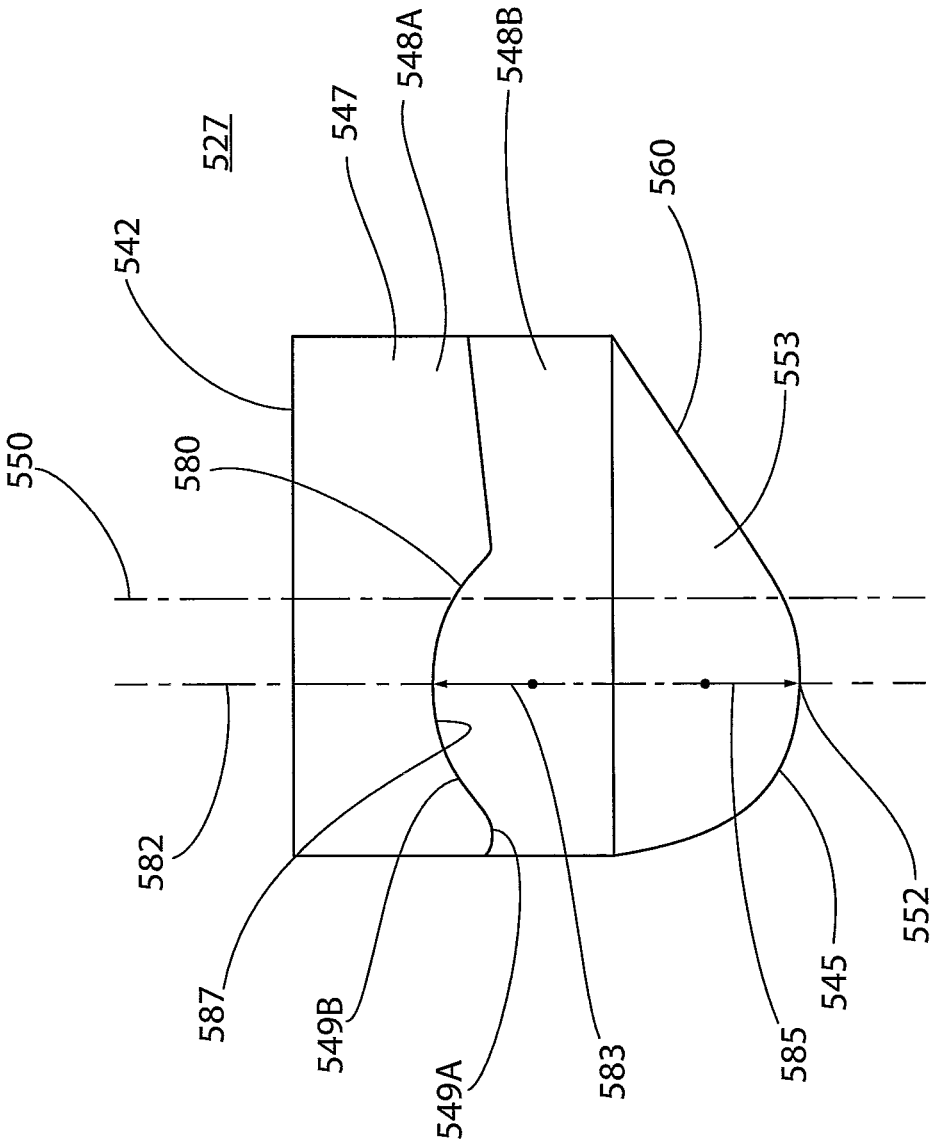

527
542
547
548A
548B
560
553
550
580
582
587
549B
549A
583
585
545
552

FIG. 14

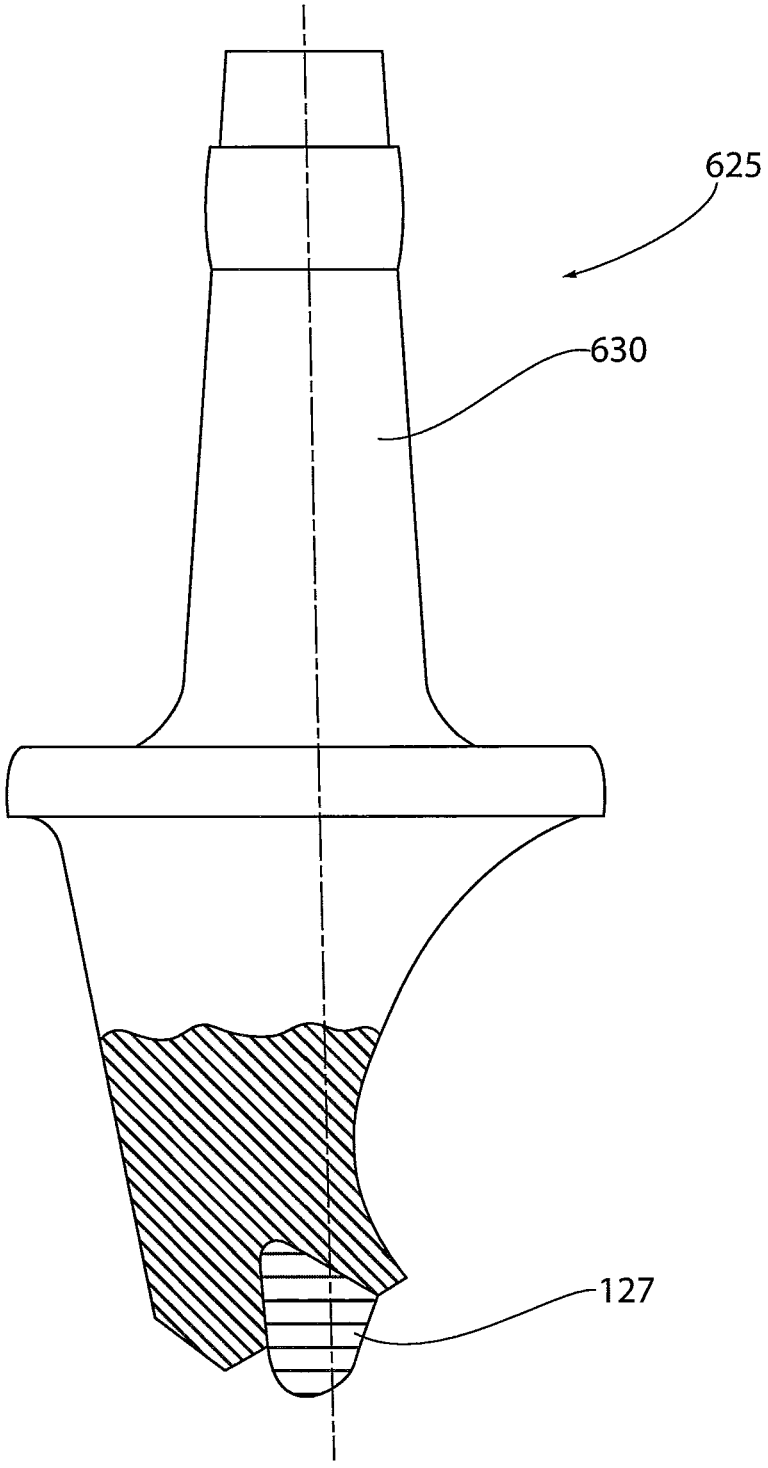


FIG. 15

INSERT WITH OFFSET APEX FOR A CUTTER BIT AND A CUTTER BIT HAVING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is related to a cutter bit that is used for the impingement of substrate for earth strata such as, for example, asphalted roadway surface, coal deposits, and mineral formations. More specifically, the invention relates to a cutter bit having a hard tip insert protruding therefrom, wherein the insert has an offset apex.

2. Description of Related Art

A cutter bit for use in mining or construction applications typically has a generally elongated cylindrical geometry. Such a cutter bit comprises an elongated steel cutter bit body which has an axially forward end and an opposite axially rearward end. A cutter insert of hard or super hard material typically affixes to the axial forward end of the cutter bit body. The cutter bit body typically is rotatably or non-rotatably secured to a stationary block or holder on a drum.

Cutter bits experience wear in a number of ways due to the environment in which they operate and must be frequently replaced. It is highly desirable to provide an improved cutter bit that experiences an increase in useful tool life as compared to heretofore known cutter bits.

FIG. **1** illustrates a portion of a continuous mining machine **10** comprised of a rotatable shaft **12** having a first sprocket **14** and an associated drive chain **15** which is driven by a second sprocket **17**. Attached to the drive chain **15** are a plurality of cutter links **20** each containing a cutter bit **25**. Each cutter bit **25** has an insert **27** which contacts earth strata S or road pavement to break up material for removal. During the operation, as the insert **27** moves through the substrate S a force FR is applied to the insert **27**. Typically, the force FR acts upon the cutter insert **27** along a line that forms an angle X with the central longitudinal axis **32** of the cutter body **30** of between 5-20°. FIG. **2** is a portion of FIG. **1** enlarged to show details of the cutter bit **25**. As illustrated in FIGS. **2** and **3**, when the force FR is applied to the insert **27** there is a region U behind the insert **27** that is unsupported. Directing attention to FIG. **3**, typically, the cutter bit **25** is comprised of the body **30** having a central longitudinal axis **32** extending therethrough. An insert holder **35** is secured to the body **30** and the insert **27** is secured within the insert holder **35**. Typically, the insert **27** has a cemented carbide body with a conical tip **28**. The insert holder **35** is carbide such that the insert **27** may be brazed into the holder **35**. Such a cutter bit is disclosed in United States Patent Application Publication No. US 2012/0242136, which is hereby incorporated herein in its entirety.

Returning to FIG. **3**, typically the resultant force FR is broken into an axial component FA parallel to the central longitudinal axis **32** and a lateral component FL perpendicular to the central longitudinal axis **32**. Because the region U is unsupported, the lateral force FL applies an undesirable bending moment to the cutter insert **27**. While the inserts are typically made of cemented carbide, they may also be made of other super hard materials. Each of these materials has a very high compressive strength but a relatively low tensile strength. As a result, a design is sought to provide additional support to the insert against the lateral force acting upon it to minimize bending moments caused by the lateral force. Additionally, in other prior art designs, the conical tip of the cutter insert **27** was not made of cemented carbide, but was made entirely of PCD (polycrystalline diamond) to compensate for the unsupported region U of the insert **27**. A design is sought that would eliminate or reduce the amount of PCD used in these inserts **27**.

SUMMARY OF THE INVENTION

An insert used for earthworking and/or road milling applications is comprised of a body with a first end and a second end. The body comprises a base extending from the first end and a central longitudinal axis through the base. The base is defined by an ellipsoid about the longitudinal axis. There is an apex at the second end, wherein the apex is offset from the longitudinal axis. There is a transition region between the base and the apex, wherein the transition region is symmetric about a plane extending through the apex and through the longitudinal axis.

Another embodiment is directed to a non-rotatable cutter bit comprising a body having a central longitudinal axis extending therethrough, an insert holder secured within the body, and an insert secured within the insert holder. The insert has a body with a first end and a second end. The body comprises 1) a base extending from the first end and a longitudinal centerline through the base, wherein the base is defined by an ellipsoid; 2) an apex at the second end, wherein the apex is offset from the centerline defining a rake face side and a relief face side; and 3) a transition region between the base and the apex. The transition region is symmetric about a plane extending through the apex and through the centerline and the central longitudinal axis extends through the apex.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is prior art and illustrates a side view of a portion of a continuous mining machine in operation;

FIG. **2** is an enlarged portion of part of FIG. **1**;

FIG. **3** is a side view with a partial sectional view of a prior art cutter bit having a symmetrical insert;

FIG. **4** is a view similar to that of FIG. **2**, however, utilizing the cutter bit in accordance with the subject invention;

FIG. **5** is a side view with a partial sectional view of a cutter bit in accordance with the subject invention including an insert having an offset apex and an insert holder to accommodate the same;

FIG. **6** is a side view of the insert, in accordance with the subject invention;

FIG. **7** is an end view of the insert, in accordance with the subject invention;

FIG. **8** is a bottom view of the insert, in accordance with the subject invention;

FIG. **9** is a perspective view of the insert, in accordance with the subject invention;

FIG. **10** is a second embodiment of the cutting bit viewed from the bottom in a manner similar to that of FIG. **8**;

FIG. **11** is a side view of the cutting insert similar to that of FIG. **5**;

FIG. **12** is a side view of a variation of the cutting insert illustrated in FIG. **5**;

FIG. **13** is another variation of a side view of the cutting insert illustrated in FIG. **5**;

FIG. **14** is a view similar to that of FIG. **6** but with a break line introduced highlighting the separation between the carbide steel portion of the insert and the PCD or CDN portion of the insert; and

FIG. **15** is a side view similar to FIG. **5** but with the insert mounted directly to the cutter bit body.

DESCRIPTION OF THE INVENTION

FIG. **4** is a view similar to that of FIG. **2**, however, substitutes the conventional cutter bit **25** with a cutter bit **125** in

accordance with the subject invention. In particular, FIG. **4** illustrates a drum assembly **100** for earthworking and/or road milling operations including all of the elements discussed with respect to FIG. **2** with the exception that the cutter bit **25** illustrated in FIG. **2** is replaced with the cutter bit **125** discussed herein. The rotary shaft (not shown) includes at least one cutter link **120** extending radially therefrom with an aperture (not shown) to accept a cutter bit **125**. Just as with respect to FIG. **2**, the force FR acting upon the insert **127** forms an angle X with the central longitudinal axis **132** of the cutter body **130** of between 5-20°. However, as can be seen, the insert holder **135** provides greater support to the modified insert **127** against the lateral force FL.

FIG. **5** illustrates the cutter bit **125** with the body **130** with the central longitudinal axis **132** extending therethrough. The insert holder **135** is secured within the body **130** and the insert **127** is secured within the insert holder **135**. Once again, the force FR has been broken into an axial component FA along the central longitudinal axis **132** and a lateral component FL perpendicular to the central longitudinal axis **132**. It is the lateral force FL that imposes the greatest bending moment upon the insert **127**.

Directing attention to FIGS. **6-9**, the insert has a body **140** with a first end **142** and a second end **145**. The body **140** comprises a base **147** extending from the first end **142** with a central longitudinal axis **150** extending therethrough. The base **147**, when viewed looking along the longitudinal centerline **150**, is defined by an ellipsoid, as illustrated in FIG. **8**.

An apex **152** (FIG. **6**) is at the second end **145** of the body **140** and is offset from the longitudinal centerline **150** by an amount Z defining a rake face side **155** and a relief face side **157**. For an insert **127** having a diameter of 0.6 inches, the apex **152** may be offset an amount Z of between 0.09 and 0.16 inches and may be 0.10 inches.

A transition region **160** extends between the base **147** and the apex **152**. The transition region **160** is symmetric about a plane **162** (FIG. **8**) extending through the apex **152** and through the central longitudinal axis **150**. The apex **152** and transition region **160** together define the insert tip **153**.

It should be noted, with respect to FIG. **5**, that when the insert **127** is mounted within the cutter bit **125**, the central longitudinal axis **132** of the cutter bit **125** extends through the apex **152** of the insert **127**. The same is true with cutter bit **25** in FIG. **3**, wherein the central longitudinal axis **32** intersects with the apex **52** of the insert **27**.

This is relevant because, as a result of this design, it is possible to interchange the cutter bit **125** in accordance with the subject invention with conventional cutter bits, such as cutter bit **25**, without changes to the lugs or other equipment used to secure the cutting bit within a machine. Therefore, it is just as easy to replace a conventional cutter bit with the cutter bit **125** in accordance with the subject invention as it is to replace it with another conventional cutter bit.

Directing attention again to FIGS. **6-9**, the region surrounding the apex **152** has a radius R which may be between 0.05 inches and 0.25 inches for an insert **27** having a diameter of between 0.20 and 0.90 inches and may be 0.57 inches. Additionally, as illustrated in FIG. **8**, when viewed along the longitudinal axis **150** toward the first end, the apex region **165** may be generally elliptical. Furthermore, the major axis **167** of the ellipse is perpendicular to the plane **162**. However, it should be appreciated that the apex region **165** may be modified such that the major axis **167** of the ellipse is parallel on the same line as plane **162** (as shown in FIG. **10**), not perpendicular, to the plane **162**.

FIG. **7** is a side view of the insert **127** illustrating that a portion **172** surrounding the apex **152** may have a flat with radiussed portions blending to the transition region **160**. While the base **147** has been described as an ellipsoid, such an ellipsoid, as illustrated in FIGS. **6** and **8**, is a cylinder. As illustrated in FIG. **10**, the base **247** may be elliptical while, as illustrated in FIGS. **12** and **13**, the base **347**, **447** may have a frusto-conical shape. FIGS. **12** and **13** also indicate that the base **347**, **447** may be rotated and the transition regions **360**, **460** and apexes **362**, **462** could remain at the same orientation. As seen for the insert **127** in FIG. **11**, which is identical to insert **127** shown in FIGS. **6-9**, the transition region **160** may, in part, be a frusto-conical section **162** having a cone centerline CL.

Additionally, the transition region **160** may include a radiussed dome **163** delimited by a line **164**. A PCD or CBN (cubic boron nitride) coating, in one embodiment, would be applied onto the cemented carbide body **142** but only to the tip **153**, which is bordered by the heavier line **154** in FIG. **11**. The thickness of the coating may be between 0.02 and 0.06 inches and the techniques for applying such coatings are well known in the art.

Returning to FIG. **6**, the rake face side **155** of the transition region **160** is generally straight extending a length L of at least one-half of the diameter D of the insert body **140** and forms an acute angle A with respect to the central longitudinal axis **150** of between approximately 35-75°, and may be 55°.

In one particular example, the base diameter D is 0.5 inches and the rake side has a straight portion for a length of approximately 0.30 inches. Additionally, as illustrated in FIG. **6**, the transition region **160** opposite the rake face side **155** defines a relief face side **157** that is generally curvilinear but may include a straight segment **175** transitioning to the base **147**. The straight segment **175** may form an angle B of between 8-14° with the central longitudinal axis **150**.

In the past, with conventional designs, it would be necessary to fabricate the tip **28** of insert **27** (FIG. **3**) entirely of PCD or CBN. However, in light of the modified geometry of the insert **127**, the resultant redistribution of forces through the insert body **140**, and reduced bending moments upon the insert body **127**, it is now possible to use a cemented carbide body **140** and only coat the tip **153**. This eliminates the need to fabricate the entire insert tip of PCD or CBN, resulting in a substantial material reduction and reduced cost.

Returning to FIG. **5**, the insert **127** is illustrated mounted within an insert holder **135**. In accordance with the subject invention, it should be appreciated that the length of RF represents the length of the rake face side **155** of the insert **127**. For at least 90% of the length of RF, a projection perpendicular to the rake face side **155** toward the longitudinal axis **132** intersects with a face **133** of the body **130** of the bit holder **135**. In the alternative, for at least 90% of the length RF of the rake face side **155**, a projection perpendicular to the longitudinal axis **132**, identified by length P, through the rake face side **155** intersects with the face **133** of the body **130** of the bit holder **135**.

What has so far been discussed is an insert **127** (FIG. **6**) having a body **130** with a base **147** having an apex **152** and a transition region **160** defining an insert tip **153**. While the base **147** has been made of cemented carbide, the tip **153**, has in one embodiment also been made of cemented carbide and coated with CBN or PCD. In another embodiment, the base **147** has been made of cemented carbide and the entire tip **153** has been made of PCD or CBN.

In another embodiment, as illustrated in FIG. **14**, the design is similar to that illustrated in FIG. **6**. The reference numbers in FIG. **14** are now in the **500** series, but unless otherwise indicated, the overall shape of the insert remains unchanged and the similar **100** series numbers in FIG. **6** identify the same

parts. The only difference is that in an earlier embodiment, the entire tip was PCD or CBN and now the PCD or CBN material extends beyond the tip and into a portion of the base.

In particular, insert **527** includes a first end **542** and a second end **545** with a base **547** and an offset apex **552** as previously described. A transition region **560** extends between the apex **552** and the base **547** and together the apex **552** in the transition region **560** define the tip **553**. In this embodiment the entire tip **560** is made up of PCD or CBN but, furthermore, while a first portion **548**A of the base **547** is cemented carbide, the remainder of the base **548**B is made up of the same material as the tip **560**. In particular, the second portion of the base **548**B and the tip **560** together are made of PCD or CBN. The first portion **548**A of the base **547** has a mating surface **549**A which conforms to a mating surface **549**B of the second portion **548**B. The first portion **548**A which is cemented carbide is bounded to the second portion **548**B which is PCD or CBN using techniques known to those skilled in the art.

Of particular interest, the mating surface **549**B of the second portion **548**B includes a protrusion **580**. The protrusion **580** may be centered about a line **582** that is offset from and parallel to the longitudinal axis **550** of the base **547**. This line **582** may extend through the apex **552**. Furthermore, the protrusion **580** may be defined by a radius **583**. It should be noted in the embodiment illustrated in FIG. **14**, the region about the apex **552** may also be defined by a radius **585**. In one embodiment the radius **583** of the protrusion **580** may be identical to the radius **585** in the region of the apex **552**. Additionally, the centers of the radii **584**, **586** may lie along the common line **582**. By providing the protrusion **580** in the second portion **584**B of the base **547**, lateral forces that may be applied to the tip **553** during operations will be resisted by the protrusion **580** mounted within a matching depression **587** of the first portion **548**A, thereby reducing the stress on the bond between the first portion **548**A and the second portion **548**B.

FIG. **15** illustrates an insert **127** identical to the insert previously discussed. However, unlike the previous embodiments, the insert **127** is mounted directly to the body **630** of the cutter bit **625**. The insert **127**, whether it is made from cemented carbide, PCD, or CBN may be secured to the steel body **630** using techniques known in the art.

While the discussion has been directed to the use of cutter bits for a mining or construction operation, it should be appreciated that the insert in accordance with this invention may also be applied to oil and/or gas drilling operations.

Furthermore, it should be appreciated that the modified insert disclosed herein provides improved performance over other conventional inserts, even when the tip is not coated with PCD or CBN.

While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. The presently preferred embodiments described herein are meant to be illustrative only and not limiting as to the scope of the invention which is to be given the full breadth of the appended claims and any and all equivalents thereof.

The invention claimed is:

1. An insert used for earthworking and/or road milling applications comprising a body with a first end and a second end, wherein the body comprises:

a) a base extending from the first end and a central longitudinal axis through the base, wherein the base is defined by an ellipsoid about the longitudinal axis;

b) an apex at the second end, wherein the apex is offset from the longitudinal axis;

c) a transition region between the base and the apex, wherein the transition region is symmetric about a plane extending through the apex and through the longitudinal axis; and

d) wherein when viewed along the longitudinal axis toward the first end, the apex region is generally elliptical and wherein the major axis of the ellipse is parallel to and overlapping with the plane.

2. The insert according to claim **1**, wherein a region surrounding the apex has a radius.

3. The insert according to claim **2**, wherein the radius is between 0.05 and 0.25 inches and the diameter of the base at the intersection with the transition region is 0.57 inches.

4. The insert according to claim **2**, wherein when viewed from the direction facing the plane, the transition region opposite a rake side is the relief side and generally curvilinear with a straight segment transitioning to the base.

5. The insert according to claim **4**, wherein the straight segment of the relief side adjacent to the base forms an angle B of between 8-14° with the centerline.

6. The insert according to claim **1**, wherein the region surrounding the apex has a flat with radiussed portions blending to the transition region.

7. The insert according to claim **1**, wherein the ellipsoid is one of a cylinder, a frusto-conical section, an elliptical section and a tapered elliptical section.

8. The insert according to claim **1**, wherein when viewed from a direction facing the plane, a rake side of the transition region is generally straight extending over one-half the diameter D of the insert body and forms an obtuse angle A with respect to the centerline.

9. The insert according to claim **8**, wherein the base diameter D is 0.50 inches and the rake side has a straight portion with a length of approximately 0.30 inches.

10. The insert according to claim **1**, wherein the transition region is conical.

11. The insert according to claim **1**, wherein a tip includes the apex and transition region and wherein the body and the tip are cemented carbide and, wherein there is a coating of PCD or CBN covering only the tip.

12. The insert according to claim **1**, wherein a tip includes the apex and transition region and wherein the body is cemented carbide and the tip is entirely PCD or CBN.

13. The insert according to claim **1**, wherein a tip includes the apex and transition region and wherein the tip and a portion of the body are PCD or CBN while the remainder of the body is cemented carbide.

14. The insert according to claim **13**, wherein the PCD or CBN portion is mated to the remaining body along mating surfaces and wherein the mating surface of the PCD or CBN portion has a protrusion.

15. The insert according to claim **14**, wherein the protrusion is centered about a line offset from and parallel to the central longitudinal axis of the body.

16. The insert according to claim **15**, wherein the protrusion is defined by a radius.

17. A non-rotatable cutter bit comprising:

a) a body having a central longitudinal axis extending therethrough;

b) an insert holder secured within the body;

c) an insert secured within the insert holder, wherein the insert has a body with a first end and a second end, wherein the body comprises:

1) a base extending from the first end and a longitudinal centerline through the base, wherein the base is defined by an ellipsoid;

2) an apex at the second end, wherein the apex is offset from the centerline defining a rake face side and a relief face side;

3) a transition region between the base and the apex, wherein the transition region is symmetric about a plane extending through the apex and through the centerline; and

d) wherein the central longitudinal axis extends through the apex.

18. The non-rotatable bit according to claim **17**, wherein for at least 90% of the length of the rake face, a projection perpendicular to the rake face toward the longitudinal axis intersects with the body of the bit holder.

19. The non-rotatable bit according to claim **17**, wherein for at least 90% of the length of the rake face side, a projection perpendicular to the longitudinal axis through the rake face intersects with the body of the bit holder.

20. The non-rotatable bit according to claim **17**, wherein the insert is brazed within holder of the bit body.

21. The non-rotatable bit according to claim **17**, wherein the insert has tip that includes the apex and transition region and wherein the body and the tip are cemented carbide and, wherein there is a coating of PCD or CBN covering only the tip.

22. The non-rotatable bit according to claim **17**, wherein the insert has a tip that includes the apex and transition region and wherein the body is cemented carbide and the tip is entirely PCD or CBN.

23. The non-ratable bit according to claim **17**, wherein the insert has a tip that includes the apex and transition region and wherein the tip and a portion of the body are PCD or CBN while the remainder of the body is cemented carbide.

24. The non-rotatable bit according to claim **23**, wherein the PCD or CBN portion is mated to the remaining body along mating surfaces and wherein the mating surface of the PCD or CBN portion has a protrusion.

25. The non-rotatable bit according to claim **24**, wherein the protrusion is centered about a line offset from and parallel to the central longitudinal axis of the body.

26. The insert according to claim **25**, wherein the protrusion is defined by a radius.

27. A non-rotatable cutter bit comprising:

a) a body having a central longitudinal axis extending therethrough;

b) an insert secured to the body, wherein the insert has a body with a first end and a second end, wherein the body comprises:

1) a base extending from the first end and a longitudinal centerline through the base, wherein the base is defined by an ellipsoid;

2) an apex at the second end, wherein the apex is offset from the centerline defining a rake face side and a relief face side;

3) a transition region between the base and the apex, wherein the transition region is symmetric about a plane extending through the apex and through the centerline; and

d) wherein the central longitudinal axis extends through the apex.

28. The non-rotatable hit according to claim **27**, wherein for at least 90% of the length of the rake face, a projection perpendicular to the rake face toward the longitudinal axis intersects with the body of the bit holder.

29. The non-rotatable bit according to claim **27**, wherein for at least 90% of the length of the rake face side, a projection perpendicular to the longitudinal axis through the rake face intersects with the body of the bit holder.

30. An insert used for earthworking and/or road milling applications comprising a body with a first end and a second end, wherein the body comprises:

a) a base extending from the first end and a central longitudinal axis through the base, wherein the base is defined by an ellipsoid about the longitudinal axis;

b) an apex at the second end, wherein the apex is offset from the longitudinal axis, wherein a tip includes the apex and transition region and wherein the tip and a portion of the body are PCD or CBN while the remainder of the body is cemented carbide;

c) a transition region between the base and the apex, wherein the transition region is symmetric about a plane extending through the apex and through the longitudinal axis;

d) wherein the PCD or CBN portion is mated to the remaining body along mating surfaces and wherein the mating surface of the PCD or CBN portion has a protrusion and wherein the protrusion is centered about a line offset from and parallel to the central longitudinal axis of the body.

31. A non-rotatable cutter bit comprising:

a) a body having a central longitudinal axis extending therethrough;

b) an insert holder secured within the body;

c) an insert secured within the insert holder, wherein the insert has a body with a first end and a second end, wherein the body comprises:

1) a base extending from the first end and a longitudinal centerline through the base, wherein the base is defined by an ellipsoid;

2) an apex at the second end, wherein the apex is offset from the centerline defining a rake face side and a relief face side, wherein the insert has a tip that includes the apex and transition region and wherein the tip and a portion of the body are PCD or CBN while the remainder of the body is cemented carbide, wherein the PCD or CBN portion is mated to the remaining body along mating surfaces and wherein the mating surface of the PCD or CBN portion has a protrusion, wherein the protrusion is centered about a line offset from and parallel to the central longitudinal axis of the body;

3) a transition region between the base and the apex, wherein the transition region is symmetric about a plane extending through the apex and through the centerline; and

d) wherein the central longitudinal axis extends through the apex.

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